

whether a conflict exists (step 230). Using the access modes described above, the read/write parameter comparison performed for each pair of potentially conflicting requests are those shown in Table 4 (step 232). That is, the conditional conflict is resolved by determining whether the write parameters for the write lock in question are a subset of the read parameters for the read lock in question. If so, then there is no conflict. If not, then the requested lock is in conflict with the outstanding previously granted lock. If none of the outstanding, previously granted locks is in conflict with the requested lock, the requested lock is granted (step 234). Otherwise it is put on a queue of pending lock requests (step 228). Every time a previously granted lock is released, any pending lock requests that overlap with the resource associated with the released lock are reevaluated (step 238).

#### Alternate Embodiments

The present invention may be implemented in DBMS's, transaction processing monitors, persistent programming languages, and concurrency control services for object resource brokerage systems. It may be distributed either in the form of such systems, or as a computer program product that is distributed on computer readable media such as magnetic data storage media (i.e., disks or tapes), CDROM, or the like. A computer program product embodiment of the present invention may be distributed electronically, over the Internet or other communications network, as a computer data signal embodied in a carrier wave.

While the present invention has been described with reference to a few specific embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. Various modifications may occur to those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A resource lock management system, comprising:

a lock data structure system which stores [storing] lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request;

wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a data reliability classification associated with the resource lock request; and

a lock manager for evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request, determining when the resource lock request is conditionally conflicting with any granted resource lock

request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource lock request by performing a predefined comparison of the parameter values for the resource lock request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes:  
a first data structure which stores information of  
a pending or granted lock request, the first data structure  
including:

a field which stores an access mode of a  
resource;

a field which stores an identification of a  
transaction associated with the first data structure; and

a field which stores parameters of a data  
reliability classification associated with a pending or  
granted resource lock request;

a second data structure which stores information  
of a lock, the second data structure including:

a field which stores an identification of a  
lockable resource which corresponds to said data  
indicating a resource to which access has been granted  
or requested; and

a field which references the first data  
structure.

2. The resource lock management system of claim 1, wherein the resource lock request is conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor unconditionally compatible with the granted resource lock request.

3. The resource lock management system of claim 2, wherein when resource lock request is a parameterized read lock request R(A), where A represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request W(B), where B represents the parameter values for the parameterized write lock request, the lock manager determines whether the resource lock request is conflicting with the granted resource lock request by determining whether or not B is a subset of A.

4. A resource lock management method,

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comprising the steps of:

storing, in a data structure system, lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request; wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a data reliability classification associated with the resource lock request; and

evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request, determining when the resource lock request is conditionally conflicting with any granted resource lock request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource by performing a predefined comparison of the parameter values for the resource lock request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes:

a first data structure which stores information of a pending or granted lock request, the first data structure including:

a field which stores an access mode of a resource;

a field which stores an identification of a transaction associated with the first data structure; and

a field which stores parameters of a data reliability classification associated with a pending or granted resource lock request;

a second data structure which stores information of a lock, the second data structure including:

a field which stores an identification of a lockable resource which corresponds to said data indicating a resource to which access has been granted or requested; and

a field which references the first data structure.

5. The resource lock management method of claim 4, wherein the resource lock request is

conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor unconditionally compatible with the granted resource lock request.

6. The resource lock management method of claim 5, wherein when resource lock request is a parameterized read lock request  $R(A)$ , where  $A$  represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request  $W(B)$ , where  $B$  represents the parameter values for the parameterized write lock request, the resource lock request is evaluated with respect to the granted resource lock request by determining whether or not  $B$  is a subset of  $A$ .

7. A computer program product for use in conjunction with a computer system, the computer program product comprising a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising:

instructions for storing, in a data structure system, lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request;

wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a classification associated with the resource lock request; and

lock manager means for evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request, determining when the resource lock request is conditionally conflicting with any granted resource lock request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource lock request by performing a predefined comparison of the parameter values for the resource lock

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request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes:  
a first data structure which stores information of  
a pending or granted lock request, the first data structure  
including:

a field which stores an access mode of a  
resource;

a field which stores an identification of a  
transaction associated with the first data structure; and

a field which stores parameters of a data  
reliability classification associated with a pending or  
granted resource lock request;

a second data structure which stores information  
of a lock, the second data structure including:

a field which stores an identification of a  
lockable resource which corresponds to said data  
indicating a resource to which access has been granted  
or requested; and

a field which references the first data  
structure.

8. The computer program product of claim 7, wherein the resource lock request is conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor unconditionally compatible with the granted resource lock request.

9. The [resource lock management system]  
computer program product of claim 8, wherein when resource lock request is a parameterized read lock request R(A), where A represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request W(B), where B represents the parameter values for the parameterized write lock request, the lock manager determines whether the resource lock request is conflicting with the granted resource lock request by determining whether or not B is a subset of A.

10. A resource lock management system  
according to claim 1, wherein the lock data structure  
system further includes a third data structure, the third  
data structure including:

a field which references the second data  
structure.

11. A resource management system according to claim 10, wherein:

the second data structure further includes:

a field which stores aggregated read parameters of first data structures referenced by the second data structure; and

a field which stores aggregated write parameters of first data structures referenced by the second data structure,

wherein the aggregated read and write parameters correspond to said one or more parameter values indicating a data reliability classification associated with the resource lock request.

12. A resource management system according to claim 11, wherein the second data structure further includes:

a field which stores an identification of a most restrictive access mode of the lockable resource and which corresponds to said access mode associated with the resource lock request.

13. A resource lock management method according to claim 4, wherein the lock data structure system further includes a third data structure, the third data structure including:

a field which references the second data structure.

14. A resource lock management method according to claim 13, wherein:

the second data structure further includes:

a field which stores aggregated read parameters of first data structures referenced by the second data structure; and

a field which stores aggregated write parameters of first data structures referenced by the second data structure,

wherein the aggregated read and write parameters correspond to said one or more parameter values indicating a data reliability classification associated with the resource lock request.

15. A resource lock management method according to claim 14, wherein the second data structure further includes:

a field which stores an identification of a most restrictive access mode of the lockable resource and which corresponds to said access mode associated with the resource lock request.

16. A computer program product according to claim 7, wherein the lock data structure system further includes a third data structure, the third data structure including:

a field which references the second data structure.

17. A computer program product according to claim 16, wherein:

the second data structure further includes:

a field which stores aggregated read parameters of first data structures referenced by the second data structure; and

a field which stores aggregated write parameters of first data structures referenced by the second data structure.

wherein the aggregated read and write parameters correspond to said one or more parameter values indicating a data reliability classification associated with the resource lock request.

18. A computer program product according to claim 17, wherein the second data structure further includes:

a field which stores an identification of a most restrictive access mode of the lockable resource and which corresponds to said access mode associated with the resource lock request.

19. A resource lock management system, comprising:

a lock data structure system which stores lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request;

wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a data reliability classification associated with the resource lock request; and

a lock manager for evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request.

determining when the resource lock request is conditionally conflicting with any granted resource lock request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource lock request by performing a predefined comparison of the parameter values for the resource lock request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes:

a first data structure which stores information of a lock, as well as the pending and granted requests thereof, the first data structure including:

a field which stores an identification of a lockable resource which corresponds to said data indicating a resource to which access has been granted or requested; and;

a field which stores an access mode of a resource which corresponds to said access mode associated with the resource lock request;

a field which stores parameters of a data reliability classification associated with a resource lock request which corresponds to said one or more parameter values indicating a data reliability classification associated with the resource lock request;

a second data structure including:

a field which references the first data structure.

20. A system according to claim 19, wherein the field which stores an access mode stores a most restrictive access mode of the granted lock requests.

21. A system according to claim 19, wherein the field which stores parameters comprises:

a field which stores read parameters; and

a field which stores write parameters.

22. A system according to 21, wherein:  
the read parameters are aggregated read parameters of granted read requests; and

a write parameters are aggregated write parameters of granted write requests.

23. The resource lock management system of claim 19, wherein the resource lock request is conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor



unconditionally compatible with the granted resource lock request.

24. The resource lock management system of claim 23, wherein when resource lock request is a parameterized read lock request  $R(A)$ , where  $A$  represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request  $W(B)$ , where  $B$  represents the parameter values for the parameterized write lock request, the lock manager determines whether the resource lock request is conflicting with the granted resource lock request by determining whether or not  $B$  is a subset of  $A$ .

25. A resource lock management method, comprising the steps of:

storing, in a data structure system, lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request;

wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a data reliability classification associated with the resource lock request; and

evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request, determining when the resource lock request is conditionally conflicting with any granted resource lock request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource by performing a predefined comparison of the parameter values for the resource lock request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes: a first data structure which stores information of a lock, as well as the pending and granted requests thereof, the first data structure including:

a field which stores an identification of a lockable resource which corresponds to said data indicating a resource to which access has been granted

or requested; and;

a field which stores an access mode of a resource which corresponds to said access mode associated with the resource lock request;

a field which stores parameters of a data reliability classification associated with a resource lock request which corresponds to said one or more parameter values indicating a data reliability classification associated with the resource lock request;

a second data structure including;

a field which references the first data structure.

26. A method according to claim 25, wherein the field which stores an access mode stores a most restrictive access mode of the granted lock requests.

27. A method according to claim 25, wherein the field which stores parameters comprises:

a field which stores read parameters; and

a field which stores write parameters.

28. A method according to 27, wherein: the read parameters are aggregated read parameters of granted read requests; and

a write parameters are aggregated write parameters of granted write requests.

29. A method according to claim 25, wherein the resource lock request is conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor unconditionally compatible with the granted resource lock request.

30. A method according to claim 29, wherein when resource lock request is a parameterized read lock request R(A), where A represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request W(B), where B represents the parameter values for the parameterized write lock request, the resource lock request is evaluated with respect to the granted resource lock request by determining whether or not B is a subset of A.

31. A computer program product for use in conjunction with a computer system, the computer program product comprising a computer readable storage medium and a computer program mechanism

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embedded therein, the computer program mechanism comprising:

instructions for storing, in a data structure system, lock data representing granted and pending resource lock requests, wherein the data representing each granted and pending resource lock request includes: data indicating a resource to which access has been granted or requested, and an access mode associated with the resource lock request;

wherein a subset of the granted and pending resource lock requests are parameterized resource lock requests and the data representing each resource lock request in the subset further includes one or more parameter values indicating a classification associated with the resource lock request; and

lock manager means for evaluating, granting and denying resource lock requests, including determining when a resource lock request is unconditionally conflicting with any granted resource lock request, determining when the resource lock request is conditionally conflicting with any granted resource lock request, and evaluating the resource lock request with respect to each conditionally conflicting granted resource lock request by performing a predefined comparison of the parameter values for the resource lock request with the parameter values for each conditionally conflicting granted resource lock request,

wherein the lock data structure system includes:

a first data structure which stores information of a lock, as well as the pending and granted requests thereof, the first data structure including:

a field which stores an identification of a lockable resource which corresponds to said data indicating a resource to which access has been granted or requested; and;

a field which stores an access mode of a resource which corresponds to said access mode associated with the resource lock request;

a field which stores parameters of a data reliability classification associated with a resource lock request which corresponds to said one or more parameter values indicating a data reliability classification associated with the resource lock request;

a second data structure including:

a field which references the first data structure.

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32. A computer program product according to claim 31, wherein the field which stores an access mode stores a most restrictive access mode of the granted lock requests.

33. A computer program product according to claim 31, wherein the field which stores parameters comprises:

a field which stores read parameters; and

a field which stores write parameters.

34. A computer program product according to 33, wherein:

the read parameters are aggregated read parameters of granted read requests; and

a write parameters are aggregated write parameters of granted write requests.

35. The computer program product of claim 31, wherein the resource lock request is conditionally conflicting with a granted resource lock request only when (A) both the resource lock request and the granted resource lock request are parameterized resource lock requests and (B) the resource lock request is neither unconditionally conflicting nor unconditionally compatible with the granted resource lock request.

36. The computer program product of claim 31, wherein when resource lock request is a parameterized read lock request  $R(A)$ , where  $A$  represents the parameter values for the parameterized read lock request, and the granted resource lock request is a parameterized write lock request  $W(B)$ , where  $B$  represents the parameter values for the parameterized write lock request, the lock manager determines whether the resource lock request is conflicting with the granted resource lock request by determining whether or not  $B$  is a subset of  $A$ .

37. A resource lock management system, comprising:

a memory which stores a first data structure which stores information of a pending or granted lock request, the first data structure including:

a field which stores an access mode of a resource;

a field which stores an identification of a transaction associated with the first data structure; and

a field which stores parameters of a data reliability classification associated with a pending or granted resource lock request;

a field which stores an identification of a lockable resource; and  
a field which references the first data structure;

a field which references the second data  
structure.

the second data structure further includes:  
a field which stores aggregated read parameters  
of first data structures referenced by the second data  
structure; and

39. A resource management system according to claim 38, wherein the second data structure further includes:

40. A resource management system according to claim 37, wherein the second data structure further includes:

41. A resource lock management system,  
comprising:

a field which stores an identification of a  
lockable resource;

a field which stores parameters of a data reliability classification associated with a resource lock request;

a field which references the first data

structure.

42. A system according to claim 41, wherein the field which stores an access mode stores a most restrictive access mode of the granted lock requests.

43. A system according to claim 42, wherein the field which stores parameters comprises:

a field which stores read parameters; and

a field which stores write parameters.

44. A system according to 43, wherein:

the read parameters are aggregated read parameters of granted read requests; and

the write parameters are aggregated write parameters of granted write requests.

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